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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/817,473	03/26/2001	Yi Xu	CS98-106/7/8C	1603

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GEORGE O. SAILE & ASSOCIATES
28 DAVIS AVENUE
POUGHKEEPSIE, NY 12603

EXAMINER

NGUYEN, THANH T

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 06/03/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/817,473

Applicant(s)

XU ET AL.

Examiner

Thanh T. Nguyen

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 24 April 2003.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 23-41 is/are pending in the application.
- 4a) Of the above claim(s) 28-41 is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 23-27 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s). _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ 6) ☐ Other: _____

DETAILED ACTION

Applicant's arguments filed 4/24/03 have been fully considered but they are not persuasive.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 23, 25, and 27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jeng et al. (U.S. Patent No. 6,114,186) in view of Lucas (U.S. Patent No. 6,287,951).

Referring to figures 1-3, Jeng et al. '186 teaches a method for fabricating multilevel metal interconnections having low dielectric constant insulators on a substrate comprising the steps of:

providing first metal lines (14), formed over the substrate (10),

coating a layer of low dielectric constant insulating material (18) on and in between the metal lines (14, col. 4, lines 31-38),

curing the low dielectric constant insulating material (18) by cured at about 300°C by a hot plate bake on the spin-coater (see col. 4, lines 39-42).

depositing a thin layer of stabilizing material (20, a silicon nitride which is a non-oxide compound, as claimed in claim 25) over the low dielectric constant insulating material layer (18), by plasma with the thickness of about 1000-3,000Å, (see col. 4, lines 42-60),

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depositing a cap silicon oxide layer (22) by PECVD with the thickness about 16000Å on the stabilizing layer (20), (as claimed in claim 27),

planarizing the silicon oxide cap layer (22) by CMP (see col. 4, lines 61-67),

repeating above steps to form multiple levels of interconnections (see col. 5, lines 6-12).

Jeng et al. '186 teaches that silicon nitride layer is used as a stabilizing layer, but fails to teach that silicon nitride can be used as an adhesion promoter layer as well. Nevertheless, such processing step is known in the semiconductor processing art as evidenced by Lucas. Lucas teaches forming a silicon nitride adhesion layer (32) over low dielectric constant insulator material layer (26) (see col.5, lines 1-13). It would have been obvious to a person of ordinary skill in the art at the time the invention was made to have used the silicon nitride layer both as an adhesion promoter layer and stabilizing layer in Jeng et al.'s process as taught by Lucas *because* inserting the silicon nitride layer between the cap silicon oxide layer and the underlying low dielectric constant material layer would eliminate the adhesion problem when cap silicon oxide layer formed over the underlying low dielectric constant material layer.

Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jeng et al. (U.S. Patent No. 6,114,186) in view of Lucas (U.S. Patent No. 6,287,951) as applied to claims 23, 25, 27, further in view of You et al. (U.S. Patent No. 6,197,703).

Jeng et al.'186 in view of Lucas does not specifically show curing the low dielectric material in the conditions at 400°C for 1 hr., in a nitrogen ambient gas flow from about 1 to 30 SLM, oxygen less than 10 ppm (as required by claim 24). Nevertheless, such processing steps are known in the semiconductor processing art as evidenced by You et al.. You et al. teaches forming a low dielectric constant material layer HSQ (24, see figure 1), which is a spin-on dielectric layer, and curing the low dielectric constant material layer HSQ (24) by baking in an

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oven in an inert gas (which includes nitrogen gas) ambient at 400°C for an hour (see col. 5, lines 10-21).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to cure the low dielectric constant layer in a nitrogen gas ambient in Jeng et al.'s process as taught by You et al. *because* curing the low dielectric constant material layer HSQ at 400°C for 1 hr., in a nitrogen gas ambient would form a layer of low dielectric constant material layer containing lower moisture/solvent in the material, therefore, it increases the adhesion strength when overlying layer is formed on the surface, and it also improves the surface uniformity and planarization.

It is would also have been obvious to a person of ordinary skill in the art at the time the invention was made that there is no oxygen in the inert gas ambient or vacuum because You et al. teaches curing the low dielectric constant material layer HSQ in an inert gas ambient or vacuum (see col. 5, lines 16-18), therefore, the oxygen content must be less than 10 ppm in an inert gas ambient or vacuum (as required by claim 24).

The specific gas flow range of the nitrogen gas as claimed are taken to be obvious since these are variables of art recognized importance which are subject to routine experimentation and optimization and discovery of an optimum value for a known process is obvious. In re Aller, 105 USPQ 233 (CCPA 1955). And, even if applicants' modification results in great improvement and utility over the prior art, it may still not be patentable if the modification was within the capabilities of one skilled in the art, In Re Sola 25 USPQ 433.

Therefore, one of ordinary skill in the requisite art at the time the invention was made would have used specific nitrogen gas flow range to cure the HSQ low dielectric constant material which has a thickness of greater 4000 angstroms (see col. 5, lines 26-35 of Jeng et al.

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'186) *because* using specific nitrogen flow rate would decrease the drying time for the solvent in the HSQ material layer to evaporate out of the material, and with the combination of specific nitrogen gas flow rate, film thickness and curing temperature could also cause the HSQ material to reflow and filling the wafer's channel.

Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jeng et al. (U.S. Patent No. 6,114,186) in view of Lucas (U.S. Patent No. 6,287,951) as applied to claims 23, 25, 27, further in view of Jeng et al. (U.S. Patent No. 5,818,111).

Jeng et al.'186 in view of Lucas does not specifically show the thickness of the silicon nitride layer between about 200-500 Å (as required by claim 26). Nevertheless, such processing steps are known in the semiconductor processing art as evidenced by Jeng et al.'111 (see figures 1, 5), Jeng et al. '111 teaches a method for fabricating multilevel metal interconnections having low dielectric constant insulators on a substrate comprising the steps of: providing first metal lines (14), formed over the substrate (10), coating a layer of low dielectric constant insulating material HSQ (18) over and in between the metal lines (14), depositing a thin layer of a stabilizing material (20, Si₃N₄) by plasma (also known as plasma enhanced chemical vapor deposition) with the thickness of about 100-3000 Å (see col. 4, lines 25-28).

It would have been obvious to a person of ordinary skill in the art at the time the invention was made to deposit a thin layer of stabilizing material by plasma with the thickness of about 100-3000 Å in the process of Jeng et al.'186 as taught by Jeng et al.'111 *because* silicon nitride with a specific range of thickness would prevent the moisture in the ambient diffuse into the low dielectric constant material HSQ layer, therefore, a more stable layer of HSQ material

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with higher degree of adhesion property and less moisture content in the material can be achieved.

Response to Arguments

Applicant's arguments filed 4/24/03 have been fully considered but they are not persuasive.

Applicant contends that Jeng et al. does not teach curing the spun on dielectric layer at 4000 °C for 1 hour. In response to applicant that You et al. teaches forming a low dielectric constant material layer HSQ (24, see figure 1), which is a spin-on dielectric layer, and curing the low dielectric constant material layer HSQ (24) by baking in an oven in an inert gas (which includes nitrogen gas) ambient at 400°C for an hour (see col. 5, lines 10-21). HSQ is a spun on dielectric layer (see figure 2, col. 5, lines 40-45), which has a low dielectric constant of 2.8 (see col. 5, lines 58-60).

Applicant contends that Jeng et al. does not teach adhesion promoter and stabilizer silicon nitride is deposited by PECVD with a thickness of about 200-500 Å. In response to applicant that Lucas teaches forming a silicon nitride adhesion layer (32) over low dielectric constant insulator material layer (26) (see col.5, lines 1-13). Jeng et al. '111 teaches depositing a thin layer of a stabilizing material (20, Si₃N₄) by plasma (also known as plasma enhanced chemical vapor deposition) with the thickness of about 100-3000 Å (see col. 4, lines 25-28).

Applicant contends that Jeng et al. does not teach cap silicon oxide deposited with a thickness of about 4000-16000Å. In response to applicant that in the rejection examiner using layer (22) as a cap silicon oxide layer (22) by PECVD with the thickness about 16,000Å on the stabilizing layer (20), (see col. 4, lines 61-62).

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Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).


A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh Nguyen whose telephone number is (703) 308-9439, or by Email via address Thanh.Nguyen@uspto.gov. The examiner can normally be reached on Monday-Thursday from 6:30AM to 4:00PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr., can be reached on (703) 308-4940. The fax phone number for this Group is (703) 308-7722.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the Group receptionist whose telephone number is (703) 308-0956 (See **MPEP 203.08**).

Thanh Nguyen


CARL WHITEHEAD, JR.
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800